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A revision of the genus Vittaria J. E. Smith

I. THE SPECIES OF THE SUBGENUS RADIOVITTARIA

(WITH PLATES 15–20 AND SEVEN TEXT FIGURES)

RALPH C. BENEDICT

In an earlier paper on the genera of the fern tribe Vittarieae* the writer endeavored to point out the natural generic and subgeneric groups of the tribe, to discuss as well some of the interesting morphological features, and to indicate also the probable relationships of the genera. The present paper deals with the species of one of the subgenera of *Vittaria* indicated in the earlier paper. Most of the work of which the results are presented here was done before the paper on the genera was published, but completion was delayed until the present. As indicated by the title of this article, it is intended to continue the study of the species of *Vittaria*, and it may be added, most of the necessary work has been accomplished.

The genus *Vittaria* as delimited in the writer's paper already cited includes all those species of the tribe Vittarieae which have a midvein with uniseriate lateral areolae along each side formed by the pinnate interlocking simple veinlets. (See FIGS. 1–3; also the illustrations of venation under each plate.) As it appears, this type of venation is practically unique among ferns, the only possible exceptions being two or three species in the genus *Polypodium* L., as used in a broad sense. From such species as these the species of *Vittaria* differ largely not only in general aspect,

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* Bull. Torrey Club 38: 153–190. *pl. 2–8.* 1911.

[The BULLETIN for July (41: 351–390. *pl. 9–14*) was issued 28 Jl 1914.]

but in more critical characters of the scales, texture, and tissues, and especially in the uniform arrangement of the sporangia in indeterminate lines along the outer portions of the veinlets. (See FIGS. 1–7, and the plates.)

The taxonomic revision of *Vittaria* presents unusual difficulties as compared with other ferns, owing to the fact that although there appear to be a fairly large number of valid species—about forty—the very simple venation pattern allows only a small range of variation in the more evident characters of gross outline and venation, so that these, the characters ordinarily used in differentiating fern species, are not available. Nearly all the species are grass-like in the outline of the leaves, and the problem is thus about the same as would be offered by a genus of grasses if no flowers and fruit were obtainable. In the case of some few species, the differences in size, outline or coloration of the leaves, or in the venation, are sufficiently marked to allow of specific determination, but in general it is necessary to study the plants microscopically and by sectioning the stems and leaves, to arrive at any understanding of the real specific characters. It has been found by this method of study that there are very considerable differences in the outline of the leaf petioles and blades as best shown in cross-section, in the arrangement of the vascular tissues in the stem and petioles, and in the kind of cortical tissue developed. The scales which cover the stems and leaf-bases, although of one pattern, often show well-marked differences in cell structure. There may also be important differences in the shape of the spores and paraphyses.

Some of the differences in these characters have been indicated by one writer or another during the last sixty years or so, but no one has used them consistently or accurately over any number of species. The last and only monographic treatment of the whole genus was that by Fée* who attempted to figure the scales, spores, and paraphyses, as well as the general appearance of the species he recognized. Unfortunately he seems to have been inaccurate. Müller† discovered differences in the scales which seemed to him to justify the description of several new species, but he appears unfortunately to have missed the really important features of scale differences and to have made several species from what should properly be included in only one. Mettenius* and Luerssen† described and figured accurately some of the important differential characters of leaf outline as seen in section, but neither writer covered many species. More recently Jeffrey‡ and Mrs. Britton and Miss Taylor§ have described and figured carefully the morphology of one or two species each. The present paper represents an attempt to describe and figure as thoroughly as necessary the differential characters of the seven species included in the subgenus *Radiovittaria*, as I have recently described it. As has been noted, these seven species are all American.

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* Mém. Foug. 3: 1852.

† Bot. Zeit. 537. *pl. 13.* 1854.

The work of which this paper, as also the earlier paper on the genera of the tribe Vittarieae, is a partial report, has been carried on intermittently during the last six years at the New York Botanical Garden. The present article was brought nearly to completion during a month's residence as research scholar during parts of November and December, 1911, also at the N. Y. Botanical Garden, and I am glad to acknowledge my indebtedness to Dr. N. L. Britton for the opportunities of study thus afforded. In general the material studied has been sufficiently cited in my earlier paper on the genera of the tribe, but important additional material has been received from the collections of Mr. W. R. Maxon in Panama, and I have also been greatly aided by Mr. Maxon's descriptions of the field conditions under which his material grew.

The present paper deals with less than one fifth of the total species of *Vittaria*, but in order that the problems of the characters and nomenclature may be clear at the start, a description of the genus and its synonymy are included and also a discussion of its division into subgenera.

VITTARIA J. E. Smith, Mem. Acad. Turin **5**: 413. *pl. 9.* 1793

(Type species *Pteris lineata* L.)

Haplopteris Presl, Tent. Pterid. 141. 1836.

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* Fil. Hort. Bot. Lips. 25–27. *pl. 27, f. 21, 22.* 1856.

† Schenk & Luerssen, Mittheil. Bot. **1**: 57. *pl. 11–19.* 1871.

‡ Phil. Trans. Roy. Soc. London **195** B: 119–146. *pls. 1–6.* 11 Je 1902.

§ Mem. Torrey Club **8**: 185–211. *pl. 28.* 1902.

(Type species *Pteris scolopendrina* Bory)

Taeniopteris Hooker, Gen. Fil. *pl. 76 B.* 1842.

[Type species *Vittaria Forbsei* Fée = *V. scolopendrina* (Bory) Thwaites]

Taeniopsis J. Smith, Jour. Bot. **4**: 67. 1841.

(Type species *V. lineata* [L.] J. E. Smith)

Ferns usually of epiphytic habit and of comparatively small dimensions, of herbaceous texture and entirely without sclerenchymatous tissue; stem slender, creeping, clothed with clathrate scales, the vascular tissue in the form of a tube (siphonostele) or a simple net (dictyostele); the phyllotaxy distichous or radial; leaves usually few, linear to linear-elliptic, usually grass-like in outline, the epidermis with scattered linear cystoliths, the leaf-trace single or double, the venation consisting of a midvein with pinnate branches which anastomose anteriorly to form a row of simple areolae along each side of the midvein; sporangia in two indeterminate submarginal or sometimes practically marginal lines along two continuous receptacles formed by the outer portions of the veinlets, the receptacle usually in a groove often of considerable depth and sometimes with the edges produced so as to serve as an indusium; a true indusium wanting; spores diplanate or triplanate; paraphyses usually present, consisting of large reddish or yellowish cells borne on simple or branching pedicels.

The generic name *Vittaria* is fortunately well established. It was based originally on a single species, *Pteris lineata* L., so that there is no difficulty as to its typification, notwithstanding the fact that by several writers another species has been recognized as type. *Pteris lineata* has even been made the type of another genus, *Taeniopsis* J. Smith. Smith based his division of *Vittaria* on the position of the sporangial line, including in *Euvittaria* the species of the type of *V. elongata* Sw., in which the fruiting line is practically marginal, the leaf margin being double and including the sporangia between the two lips. This type, however, as Luerssen has shown, is not generically different from that of *V. lineata*, in which the lines of sporangia are clearly submarginal and dorsal. The extremes of the two types are connected by all possible intermediate forms among the various species.

Haplopteris Presl was based on the largest species in the genus, *V. scolopendrina* (Bory) Thwaites. Superficially this is very different from species like *V. lineata* and *V. sikkimensis* Kuhn, but in its essential characters it does not appear to have even subgeneric differences from *Euvittaria*. *Taeniopteris* Hooker is a straight synonym of *Haplopteris*, as its original species seems to be identical with *V. scolopendrina*.

The only other possible nomenclatorial difficulty in connection with *Vittaria* concerns the name *Oetosis* Necker,* published in 1790. Of course if this name were to be found valid, its seniority of three years would give it precedence of *Vittaria*. It is, however, like most of Necker's names, quite without definite typification, and if recognized as originally described, would comprise in its six Linnaean species five widely separated genera. I make this statement with entire assurance notwithstanding the fact that Dr. E. L. Greene has concluded from the same evidence that Necker intended *Oetosis* to include only one Linnaean species, *Pteris lineata*, the type of *Vittaria*. Since Christensen also is not certain that *Oetosis* might not properly replace *Vittaria*, it may be worth while to give in some detail the evidence which needs to be considered, particularly as it bears on questions relating to other Neckerian names.

To begin with, it may be stated that Dr. Greene's error springs from two incorrect premises. These are: first, that Necker intended his description of *Oetosis* to be applied only to one Linnaean species of *Pteris*, instead of to several; and second, that when Necker referred to Linnaean plants, he had reference to the first edition of Species Plantarum and to no other work of Linnaeus. I am indebted to Dr. J. H. Barnhart for the discovery of both these inadvertencies.

In correcting the second of these mistakes, it is almost sufficient to suggest that it is scarcely probable that Necker would have used such an out-of-date work as the first edition of the Species Plantarum when there were two later editions of the same book, as well as several later editions of Linnaeus's Systema Naturae, the latest of these having appeared in 1784, six years before Necker's Elementa Botanica appeared. The case is about the same as at present with the various editions of the floras of the

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* Elementa Botanica 3: 318. 1790.

United States. Only the latest editions are of any general interest or use.

For incontrovertible evidence, however, that Necker used later texts than the 1753 Species Plantarum, I am able to cite two distinct references which I owe to Dr. P. A. Rydberg and which definitely identify the Linnaean work to which Necker is referring as the fourteenth edition of the Systema Naturae, the work of John Murray and not of Linnaeus. These references are Necker, Elementa Botanica **2**: 94, and **3**: 12.

The other of Dr. Greene's misconceptions has to do with the wording of Necker's original description of *Oetosis*, which is as follows:

> 1726. CHAR. DIAGN. *Lineae*, parallelae, ad periphaeriam frondium, in aversa pagina.
> *Frondes simplices.*
> CHAR. PEC. *Fructific.* lineae parallelae, ad periphaeriam in aversa pagina frondium sitae.
> *Globuli*, coacervati; singuli, annulo elastico cinguntur.
> *Besimina* in globulis inclusa, exigua, fertilia.
> *Individua neutra* in hac specie, stipitata.
> *Frondes simplices.* Quaed. Pterid. *Linn.*

In the first place, it seems to me *a priori* improbable that Necker could have intended this description to apply to only a single Linnaean species of *Pteris*. "Quaed." is of uncertain number as far as its form is concerned, but I believe in this case it is certainly plural. A general examination of Necker's text will show that the generic names used are either Linnaean names or else they are new; that is, apparently he has either retained the Linnaean genera exactly, or he has divided them, retaining the old name for part of the species and proposing a new name for the others. Often in such a case, it is evident that Necker's new genus corresponds exactly to some species-group recognized by Linnaeus. The present case furnishes a good illustration of this point.

The genus *Pteris* as delimited in the first edition of Species Plantarum (and later texts) is divided into three groups as follows:

"Frondibus simplicissimis
"Frondibus simpliciter pinnatis
"Frondibus sub-compositae"

Necker retains *Pteris* to include, as he writes, "*frondes compositae.*" In *Oetosis*, however, the leaves are "simplices," and it is reasonable to suppose that he meant to include under this name all the Linnaean species of *Pteris* with simple leaves. In the 1753 Species Plantarum there are four of these, but by 1767 two others had been added, and this is also the number in Murray's edition of the Systema Naturae of 1784. This fact seems to have been overlooked by Dr. Greene, but it was noted by Kuntze, who in attempting to validate *Oetosis*, selected as type of the genus the first species named in the later Linnaean works, i. e. *Pteris piloselloides* L., which, however, was not among the four known to Linnaeus in 1753. Thi would identify the genus with a group of the tribe Polypodieae, now known either as *Drymoglossum* Presl, or perhaps more properly as *Pteropsis* Desvaux.

It is probably unnecessary to pursue further the *ignis fatuus* of a type for *Oetosis*, but it may be stated with certainty as additional confirmation of the invalidity of this name that Necker's description does not, as was Dr. Greene's main contention, fit *Pteris lineata* better than any other of the simple *Pterides* known to Linnaeus. The specific phrase which he cited as diagnostic, "lineae parallelae," may be applied as well to the *Pteris piloselloides* of Linnaeus, but it is scarcely probable that Necker had any thought of distinguishing generically between one species which has sporangial lines exactly parallel as in *Vittaria lineata*, and another in which the lines diverge from the parallel one or two degrees as in Linnaeus's *Pteris lanceolata* and others.

Subgenus RADIOVITTARIA Benedict, Bull. Torrey Club **38**: 166. 191

Stem radial, phyllotaxy polystichous, leaf-trace always single, stem and petioles brown, owing to the highly developed collenchyma. Spores diplanate, paraphyses with cupuliform terminal cells.

The radial stem structure and leaf arrangement as well as the specialized collenchyma (see FIG. 6) serve to separate the species included from the other species of the genus, which also show a much wider range of characters.

In the key which follows, the species are arranged as nearly as possible according to natural relationships. *V. minima*, the simplest of the species treated, belongs at the bottom of the series, and is probably like the primitive form from which the others have been derived. The remaining six species fall naturally into two groups as indicated.

In connection with the species-descriptions, complete citations of the specimens examined are given. The letters following the individual citations refer to the herbarium in which the specimen is located. "U" represents the Underwood Fern Herbarium of the New York Botanical Garden; "N" the National Herbarium at Washington; "E" the Eaton Herbarium at Yale; "C" the Herbarium of the Botanisk Museum of Copenhagen.

- Leaves 3–6 mm. long. 1. *V. minima.*
- Leaves more than 6 mm. long.
  - Petioles 2-angled from near the base, lamina with a ventral ridge along the midvein
    - Sporangial line 0.5–1 mm. from the margin, lamina linear.
      - Lamina less than 1 cm. broad (4–7 mm.), the areolae longitudinal. 2. *V. Gardneriana.*
      - Lamina usually more than 1 cm. broad, the areolae oblique. 3. *V. remota.*
    - Sporangial line 2–3 mm. from the margin, lamina elliptic to lanceolate. 4. *V. latifolia.*
  - Petioles terete or oval in section except near the top, lamina without a ventral ridge.
    - Scales unicostate (rarely 2–3 costate), sporangia in two narrow deep grooves about 0.5 mm. from the margin. 5. *V. stipitata.*
    - Scales always pluricostate, sporangia in a shallow groove 1–1.5 mm. from the margin.
      - Lamina 4–10 mm. broad, the margins parallel, scales of the petiole longer and narrower than those of the stem. 6. *V. Ruiziana.*
      - Lamina 8–14 mm. broad, narrowed both ways from the middle, scales all alike, with heavy costae. 7. *V. Williamsii.*

1. VITTARIA MIMINA (Baker) Benedict, Bull. Torrey Club 38: 164. 5 My 191

Antrophyum minimum Baker, Ann. Bot. 5: 448. 1841.

Hecistopteris minima Benedict, Bull. Torrey Club 34: 457. 19 O 1907.

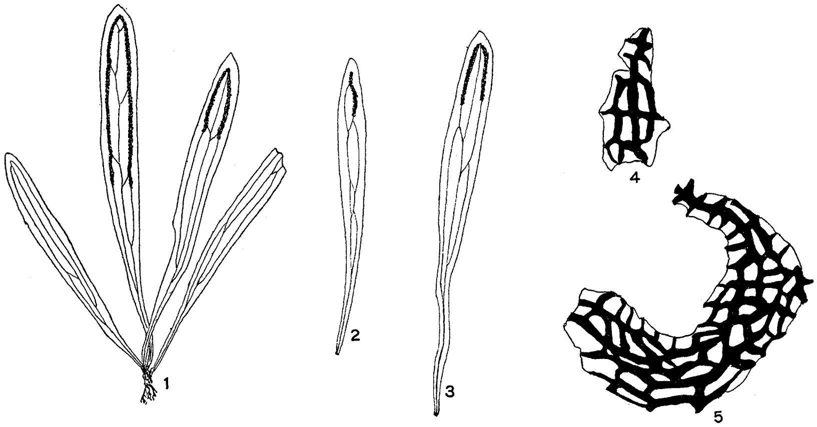
Antrophyum Werckleanum Christ, Bull. Herb. Boiss. II. 5: 11. 1905.

Hecistopteris Werckleana Christ, Bull. Herb. Boiss. II. 7: 265. 1907.

Stem slender, 4–5 cm. long, the scales small, often contorted, 4–6 cells wide at the base, the costae rather heavy; leaves few, spreading, 3–6 cm. long, the petiole brownish, the lamina oblong or lanceolate, broadest about the middle, 4–7 mm. broad, long-acute or sometimes blunter and forked, the margins plane, the leaf-trace single, dividing to form 2–8 veinlets, the areolae parallel to the midvein; sporangial line nearly straight, 1.5–2 mm. from the margin, superficial, the paraphyses as in the other species of the subgenus. (TEXT FIGS. 1–5.)

TYPE from COSTA RICA: *Endres, 1869*, 5,000 ft. altitude.

SPECIMENS EXAMINED. COSTA RICA: (without definite localities), *Endres*, type; *Wercklé*, 1903 (= *Hecistopteris Werckleana* Christ).



FIGS. 1–5. *Vittaria minima* (Baker) Benedict. Figures 1–3 show general habit of species, soriation, and venation. (All natural size.) Figures 4 and 5 illustrate a small and a large scale from the stem (enlarged about 60 times). All the drawings are from material of the original collection of Endres.

To *Vittaria minima* may be accorded the distinction of being the simplest species in the genus, and it is also one of the few species of *Vittaria* which can be adequately differentiated by a knowledge of its more evident characters of size and venation. There is no other American species with which it need be confused, and the smallest Old World species, *V. sikkimensis* Kuhn, has a different outline and texture and bears the sporangia in distinct grooves, to say nothing of other marked differences. The material illustrated (*Endres*) does not show the narrowed apices believed to be characteristic of the species, but the blunting appeared to be abnormal. In the Wercklé material, of which two plants and a photograph of a series of plants were seen, the narrowed almost acuminate tip was an evident character.

Vittaria minima, in spite of its obvious differences from the other species, falls naturally into the genus and into the subgenus *Radiovittaria*. There was so little material that no attempt was made to section the stem or petiole, but the brown coloration of the petiole probably indicates the presence of the kind of collenchyma found in this subgenus. The fact that the spores and paraphyses are indistinguishable throughout the seven species is further evidence of close relationship.

It is also worthy of note that there appear to be good grounds for believing that *V minima* is a real connecting species between *Vittaria* and *Hecistopteris* J. Smith, as has already been indicated in the synonymy. The occurrence of identically the same type of paraphysis and spore in *Hecistopteris*, as well as the suggestively similar leaves sometimes developed in this genus, lead to the suspicion that *Hecistopteris* is probably more a genus of taxonomic convenience than one of generically different evolution.

2. VITTARIA GARDNERIANA Fée, Mém. Foug. 3: 15. *pl. 3.* 1851

Vittaria Karsteniana Mett. Ann. Sci. Nat. Bot. V. 2: 207. 1864. (Type from Colombia.)

Vittaria gracilis Kuhn; in Moritz, Linnaea 36: 67. 1869. (Type from Colombia.)

Rhizome erect, unbranched, 1.5–2.5 cm. long, with the persistent petiole bases about 0.05 cm. thick (about 2 mm. thick in section), radially symmetrical, the scales brown, iridescent, soft, lanceolate, 5–8 cells wide at the base. Leaves several, erect or spreading, 20–40 cm. long, usually very thin, the petiole solid, about 1 mm. thick (less when dry), terete at first, but soon becoming flattened and angled laterally, dull brown or greenish brown, or becoming polished, 1–3 cm. long, the lamina broadest (3.5–7 mm.) near or just above the middle, narrowed very gradually above and below, with or without a median brown stripe extending a few centimeters along the surface from the petiole, either thin, and with all the veins prominent, or thicker, and with the veins immersed, but with a strong convexity over the midrib along the ventral surface, the margins acute, plane, the leaf-trace single, thick-reniform in section, branching in the very base of the petiole to form the midrib and secondary veinlets, the veinlets intersecting, 1.5 cm. apart along the margin, the marginal portions forming a nearly straight line, the areolae with their axes parallel to the midrib; soral line nearly straight, about 0.5 mm. from the margin, sunken in a shallow open groove, the paraphyses numerous, pyriform, becoming collapsed and wrinkled, the spores diplanate. (PLATE 15.)

TYPE from BRAZIL: Organ Mts., *Gardner 147*, 1837.

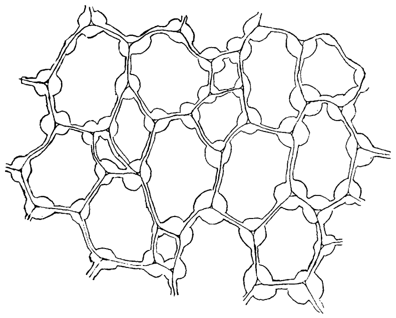
SPECIMENS EXAMINED. BRAZIL: Organ Mts., *Gardner 147* (scraps of type, U); *Glaziou 3553* (C). COLOMBIA: Santa Marta, 6000 ft., *H. H. Smith 1112 in part* (several plants, U, N); Bogota, *Lindig 176, vide V. Karsteniana* (U). VENEZUELA: Tovar, *Fendler 259 b* (U, E). ECUADOR: "crescit in silv. trop. et suband.," *Sodiro* (U); *Jameson 1116* (E); Quitensian Andes, *J. P. Couthouy 25*, 1885 (E). BRITISH GUIANA: Mt. Roraima, *Mt. Roraima Expedition 212*, 12 Nov. 1884 (N).

Fée cites in addition: MEXICO, *Goudot, Pl. Mex.* and Colombia, *Moritz 1226*. For *V. Karsteniana* Mettenius cites specimens as follows, all from COLOMBIA: San Pedro, prov. Ocaña, *Schlim 318;* Bogota, altit. 2,800 m., La Peña, altit. 2,900 m., *Lindig 176;* Quindio, altit. 3,000 m., *Triana;* Tolima, *Goudot.* The type of *V. gracilis* is from COLOMBIA: Tovar, *Moritz 464.*

Vittaria Gardneriana and *V. remota* are species of similar habit and appearance and are undoubtedly closely related to each other. Broad leaves of *V. Gardneriana* are not easy to distinguish from narrow leaves of *V. remota*, but in general, taking whole plants, the differences in breadth of leaves, etc., appear sufficiently constant to warrant the recognition of two species, especially as these differences seem to accompany partly separated geographic ranges. The material from Central America, where both species occur, offers no special difficulties in differentiation, even in the herbarium, and it is not unlikely that field study will discover additional differences. *V. Bommeri* Christ, referred to later in the present article as a species of uncertain identity, is apparently of the same general size and shape as *V. Gardneriana.*

3. VITTARIA REMOTA Fée, Mém. Foug. 7: 26. *pl.* 20, *f. 1.* 1857

Rhizomes erect, often associated in clumps of 5 or 6, 0.5–2 cm. long, about 2 mm. thick in section, radially symmetrical, the scales lanceolate, brown, 7–11-costate at the base, the median costae considerably thickened; leaves 2–10, cespitose, 15–42 cm. long, the petioles purplish-brown, sparsely verrucose, solid, 1–5 cm. long, about 2 mm. thick, nearly terete at first but soon flattened and angled, the laminae linear-lanceolate, broadest (6–18 mm.), about the middle, somewhat acuminate, below very gradually narrowed and marked with a dark brown stripe both ventrally and dorsally, the margin plane, thin and sharp, the leaf-trace single, branching in the base of the petiole, the midrib marked ventrally by a distinct angled ridge, whitish on the dorsal surface, veinlets 4–9 per cm., intersecting 0.5–1.5 cm. apart along the margin, the areolae linear, with the long axes usually divergent from the midrib; soral lines slightly crenate, 0.5–1 mm. from the margin, in an open shallow groove. (PLATE 16 and TEXT FIGS. 6, 7.)



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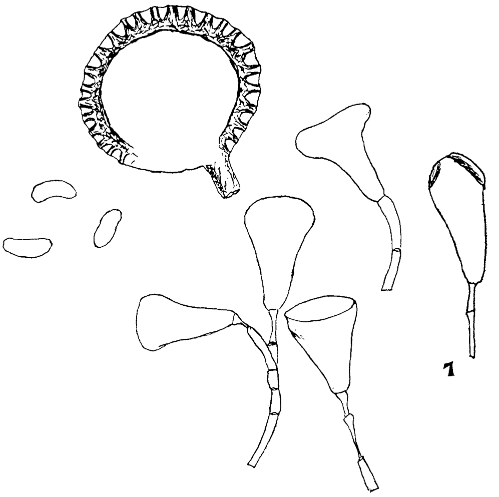

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FIGS. 6 and 7. *Vittaria remota* Fée. FIG. 6. Well-developed collenchyma from the stem. (Material collected by *P. Wilson 81*, Porto Rico. Enlarged about 300 times.) FIG. 7. Showing spores, paraphyses, and a sporangium. (Enlarged about 60 times.) Two of the paraphyses, the lower two, are shown partly collapsed, their usual condition when dry. (From material collected by *R. S. Williams 889*, Panama.)

TYPE from COLOMBIA: province of Ocaña, altit. 2,400 m., on trees in forest, *L. Schlim 611*, 1846–52.

SPECIMENS EXAMINED. VENEZUELA: Tovar, *Moritz 143 in part* (U); Tovar, altit. 2,300 m., *Fendler 260* (U, E). PANAMA: Cana, 2,000 m., *R. S. Williams 889* (U). COSTA RICA: La Palma, altit. 1,450–1,550 m., *Maxon 397* (U, N); La Palma, *C. Brade,* 26 Mr 1908 (N); *L. C. Wercklé,* 1901–05 (U, N). JAMAICA: numerous collections by *Jenman* (U), *Underwood* (U, N); *Maxon* (U, N), *Harris* (U), and *Clute* (U, N). PORTO RICO: Sierra de Luquillo, *P. Wilson 81* (U, N); *Sintenis 1139* (U, N); Sierra de Naguabo, *Sintenis 5451* (U, N); El Yunque Mts., *Everman 674* (N); *Blauner 307* (U).

Vittaria remota seems to be the commonest West Indian species of this subgenus, at least as far as representation in herbaria is concerned. It is most easily distinguishable from the preceding species, as has been noted, by the greater breadth of the leaves. In scales and rhizome, it is generally similar.

4. **Vittaria latifolia** sp. nov.

Rhizome erect, unbranched, 1–2 cm. long, with the persistent petiole bases and roots about 5 mm. thick, 2–3 mm. thick in section, radially symmetrical, the leaves and roots arising from all sides, the scales ciliate, dull brown, very soft, lanceolate, 7–10-costate at the base, the costae uniformly slender; leaves 3–6, erect or spreading, 12–22 cm. long, the petioles solid, about 2 mm. thick, flattened and laterally angled except at the very base, dull brown or greenish, 1–4 cm. long, the scales like those of the rhizome but smaller, the lamina herbaceous, thin, narrowly lanceolate, broadest (1.5–2.2 cm.) near, usually somewhat above, the middle, acute with a blunt apex, narrowed very gradually below into the petiole, the margins thin, sharp, often reflexed, the leaf-trace simple, branching in the base of the petiole, the midrib evident along the ventral surface of the lamina as a slight but distinctly angled ridge, and marked below by a whitish line, the veinlets alternate, rather prominent when dry, whitish below, divergent from the midrib at an angle of 20°, bent forward near the margin and connivent with the anterior veinlet, the areolae thus formed simple, 3–4 mm. broad, elongate-rhomboid, the oblique sides about 20 mm. long, the marginal and costal sides about 10 mm. long; sporangia and paraphyses borne along the intersected portions of the veinlets, forming a continuous shallowly crenate soral line, 2–3 mm. distant from the margin, superficial or scarcely immersed, the spores diplanate, the paraphyses pyriform or cyathiform, rounded at first, but soon collapsing and becoming angular and ribbed. (PLATE 17.)

TYPE collected at Santa Barbara, BOLIVIA, altitude 5,500 feet, *R. S. Williams 1337*, 30 August 1902.

Vittaria latifolia is interesting as having the broadest laminae in proportion to their length of any species of the genus. It is so different from the ordinary type of *Vittaria* as represented by *V. lineata* that one might well be excused for regarding it as a different genus until the vittarioid venation is discovered. It represents an extreme development of the type seen already in *V. remota* and *V. Gardneriana*, but is well differentiated from these not only by its greater width, but by scale characters as well.

5. VITTARIA STIPITATA Kunze, Linnaea **9**: 77. 1835.

Rhizome erect, 1–2 cm. long, usually branching several times, the branches fasciculate, forming a close cluster 0.5–2 cm. thick, radially symmetrical, the scales linear, unicostate, or sometimes with 2–3 costae at the base, thick and bent.

Leaves pendent, one or two on each rhizome branch, 12–100 cm. long, the lamina linear, parallel-sided through much of its length, gradually narrowed above and below (about 0.75 mm. thick), the surfaces usually smooth and plane, or sometimes with a low median ridge along the ventral surface, the margins thick, usually blunt, the petiole 3–9 cm. long, about 1 mm. thick, brown or purplish-brown, hard, partly hollow, terete below becoming flattened dorsiventrally and angled in the upper part, the leaf-trace single, dividing to form the midvein and two lateral veinlets in the base of the petiole, the veins not evident on either surface of the lamina, the veinlets intersecting 2.5–4 cm. apart, along the margin, the areolae with the long axes longitudinal; soral lines straight, 0.5 mm. from the margin, in deep narrow grooves inclined to the margin. (PLATE 18.)

TYPE from PERU: (definite locality not given), *Poeppig 176*.

SPECIMENS EXAMINED, UNDERWOOD FERN HERBARIUM. BOLIVIA: Tigre Pata, 2,000 m., *R. S. Williams 1338*, 10 F 1902; Yungas, *H. H. Rusby 340*, 1885; Yungas, *M. Bang 353*, 1890. BRAZIL: prope Rheos, *Martius 386*, Herb. Flora Brazil, 1839. COLOMBIA: *H. H. Smith 1112* in part, 20 Au 1898 or 1899; Sierra de Onaca, Sta. Marta, "moderately common on trees in forest," *2538;* Minca Estate, near stream, Sta. Marta, 800 m. (2 sheets); Atrato and Truando, *Schott 61*, D 1857. COSTA RICA: *L. C. Wercklé*, 1901–1905; *Tonduz 12782* (scraps), N 1898. CUBA: *C.*

Wright 865, "Cuba orientali, prope villam Monte Verde; in arboribus," Ja–Ju 1859; forested slopes of the Finca las Gracias, Yaleras, Oriente, about 500 m.; on trunk of dead (lodged) tree, *W. R. Maxon 4476*, 5 My 1907. JAMAICA: vicinity of Troy, 600–660 m., *W. R. Maxon 2972*, 30 Je 1904; on trees over Ginger and Ugly Rivers, St. Mary's Parish. *G. S. Jenman*, 1874–79. PANAMA: above Penonome, 650–1,000 m., *R. S. Williams 456*, Mr 1908; Cana and vicinity, 1,900 m., *R. S. Williams 890*, Ap-Je 1908. PERU: Cumbassauma Mts. (scrap); *Poeppig 176* (scraps of type).

SPECIMENS EXAMINED, U. S. NATIONAL HERBARIUM. BOLIVIA: Yungas, *Bang 353*. BRAZIL: *Riedel;* San Paulo, Rais da Serra, "ad arbores," *L. Wackett*, 1907; COLOMBIA: *H. H. Smith, 2568*, 800 m.; COSTA RICA: *Wercklé* (2); Las Vueltas, Tucurrique, 630 m., *A. Tonduz 12782*, N 1898. CUBA: *C. Wright 865; W. R. Maxon 4476*. ECUADOR: Rio Talesa, 1,400 m., *J. Rimhart 72*.

SPECIMENS EXAMINED, EATON HERBARIUM. COLOMBIA: Atrato and Truando *A. Schott 61*, D 1857. CUBA: Cuba orientali, *C. Wright*, Ja-Je 1859. (2). VENEZUELA: Tovar, 2,000–2,300 m., *A. Fendler 259*.

SPECIMENS EXAMINED, HERBARIUM OF THE BOTANISK MUSEUM. BRAZIL: San Paulo, Santos, *Riedel. H. Mosen 3526*. CENTRAL AMERICA: *Oersted*. COLOMBIA: *Moritz 143* in part.

The great variation in length of specimens included under this species is one of the most notable facts. There can, however, be no doubt as to the identification of all the material as this species. The unicostate scales give a simple and very easily applicable test by which it can be separated from the following species or any other of this group. It seems to grow under a wide range of conditions, this presumably accounting for the variation in size, the small specimens being probably only physiological forms. In the West Indies it rarely reaches as full development as in South America, but even the smallest specimens measured were usually fertile.

6. VITTARIA RUIZIANA Fée, Mém. Foug. **3**: 16. *pl. f. 3*. 1852

Vittaria Moritziana Mett. Ann. Sci. Nat. Bot. V. **2**: 207. 1864.
Vittaria Orbignyana Mett. in Kuhn, Linnaea **36**: 66. 1869.
Vittaria longipes Sodiro, Crypt. Vasc. Quitenses 417. 1893.

Rhizome erect, 1–2 cm. long, unbranched or branching to form a close cluster of shoots, each radially symmetrical, the scales 6–10-costate at the base, the median costa much thickened in the upper portion of the scale. Leaves pendent, 1–5 to each shoot, 40–70 cm. long, the petiole 5–15 cm. long, atropurpureous, hard, partly hollow, flattenedto the base, becoming 2-angled toward the lamina, the scales very narrow and elongate, 1–4-costate, the lamina linear, parallel-sided through most of its length, 4–10 mm. broad, narrowed gradually above and below, the dorsal surface plane or nearly so, the ventral surface with a broad low median ridge, the margins usually thin and sharp, often reflexed in old leaves, the leaf-trace single, dividing in the base of the petiole, the veins not evident on either surface of the lamina, the veinlets intersecting about 3.5 cm. apart along the margin, the areolae linear-rhomboid, the longitudinal sides about 3.5–4 cm. long, the oblique sides 2.5–3 cm. long. Soral lines straight, about 1–1.25 mm. from the margin, in a shallow open groove. (PLATE 19.)

TYPE from PERU: (definite locality not given), *Ruiz.*

SPECIMENS EXAMINED. COLOMBIA: Tablazo, Tuluá, *I. F. Holton 60*, 26 O 1853, "*V. stipitata*," "et in Ibaque" (U); Santa Marta, *H. H. Smith 1112* in part (N); *Lindig* (scrap, U). ECUADOR: S. Domingo, *Sodiro*, "*V. stipitata.*" VENEZUELA: Tovar, *Moritz 143, 143b* (scraps, U); Tovar, *Fendler 259*, 1854–5, "*V. stipitata*" (E).

For *V. Moritziana*, Mettenius cites as type: Canoas, COLOMBIA, *Lindig 319;* for *V. Orbignyana:* Yungas, BOLIVIA, *d'Orbigny 229.* For *V. longipes*, Sodiro cites as type-locality: subandine woods of western range in the valley of Nanegal, near Anca (translated).

As may be seen from the synonymy this species has been recognized as distinct by several writers. The material of it is rather scanty, indicating that it must be rare. It furnishes an especially good illustration of the habit of writers of describing species of *Vittaria* on very insufficient data. It is possible of course that there may be more than one species represented under this name, but there are not now sufficient data for such differentiation, even on the basis of the most careful microscopic study, although much less than that was counted sufficient for the original descriptions.

The species is easily distinguishable from *V. stipitata* on the basis of the scales, which are broad, many-costate, and of two sorts.

The margins are also usually sharper than those of *V. stipitata*, and the sporangia are borne in shallower grooves.

7. **Vittaria Williamsii** sp. nov.

Rhizome erect, 0.5–1 cm. long, 2–2.5 mm. thick, unbranched, radially symmetrical, the scales small, lanceolate, blackish-costate at the base. Leaves 1–3, 25–70 cm. long, rather thick and rigid when dry, the petiole 10–15 cm. long, hard, terete or nearly so at the base, soon becoming flat and angled, hollow above the base, atropurpureous or green along the anterior ventral portion of the stipe, the lamina linear-lanceolate, 8–14 mm. broad, narrowed gradually both ways from the middle, plane or somewhat recurved, the apex somewhat acuminate, the margin thin, sharp, plane, the lower dorsal surface marked with a median purplish stripe extending up from the petiole: leaf-trace one, dividing in the base of the petiole, the midvein not evident on the surface, the veinlets not evident on the surface, intersecting 1.5–2 mm. apart, the areolae about 2 mm. broad, linear-rhomboid with the long axes at an angle of about 15° to the midvein; sporangia in a straight or slightly sinuate line, about 1 mm. from the margin, in an open very shallow groove. (PLATE 20.)

TYPE from BOLIVIA, Santa Ana, altitude 1,800 meters, *R. S. Williams 1349*, 29 Jl 1902.

Also collected at Yungas, BOLIVIA, altit. 1,300 m., *H. H. Rusby 339*. 1885.

It is always a pleasure to work with Mr. Williams's specimens owing to the excellence of their preparation. The present species is no exception. It is as well distinguished from the other species of this subgenus as is *V. latifolia* also collected by him. Its association is, however, clearly with the species of the *stipitata* alliance of which it is the broadest example.

SPECIES INQUIRENDA

Vittaria Bommeri Christ, Bull. Herb. Boiss. II. 5: 11.

I have seen a fragment of the original specimen of this species through the kindness of His Highness, Prince Roland Bonaparte, in whose herbarium it is deposited. I have not, however, enough to determine certainly the specific characters, although it appears to be close to *V. Gardneriana* Fée.

Explanation of plates 15-20

Unless otherwise noted, the reductions and magnifications are as follows: tracings of whole plants and leaves reduced one-half; leaf and stem sections enlarged twelve times; scales enlarged about thirty-five times. The sections and scales were drawn by means of a camera lucida.

PLATE 15. VITTARIA GARDNERIANA Fée

FIG. 1. Whole plant, showing general habit and soriation.
FIG. 2. Cross-section through leaf in fertile part.
FIG. 3. Cross-section through petiole, showing 2-angled character.
FIG. 4. Single broad leaf from another plant, showing venation.
FIG. 5. Cross-section same leaf, showing similarity to *V. remota* Fée.
FIG. 6. Cross-section of petiole of same leaf.
FIG. 7. Cross-section of another leaf through fertile portion.
FIG. 8. Cross-section of petiole of same leaf.
FIG. 9. Typical scale.

Specimens figured: figures 1–6, *H. H. Smith 1112*, Santa Marta, Colombia (this number includes also *V. Moritziana* Mett.—see *plate V*, and *V. stipitata* Kunze—see *plate IV, fig. 20*); 7–9, Gardner, Organ Mts., Brazil 1837, *probably part of type collection.*

PLATE 16. VITTARIA REMOTA Fée

FIG. 1. Whole plant, showing general habit, venation, and soriation.
FIG. 2. Cross-section through fertile part of leaf.
FIG. 3. Cross-section of leaf just below fertile part.
FIG. 4. Cross-section of leaf still lower down than preceding.

FIG. 5. Cross-section through petiole more than 2 mm. above stem, to show angled character.

FIG. 6. Cross-section through petiole just after it leaves the stem. The angles are not developed at this point, but the single leaf-trace has already given off the lateral veinlets.

FIG. 7. Cross-section through stem, showing origin of petiole—at left—and a still younger leaf-trace—at right. A root is shown just leaving the stem at the lower side.

FIG. 8. Cross-section of a broader leaf through the fertile part, showing that the sporangia are borne in a slight depression.

FIGS. 9–12. Cross-sections of same leaf, comparable to those in figs. 4–6, but each respectively lower than the corresponding one in the first series.

FIGS. 13–15. Tracings from leaves showing abnormal modifications in the venation.

Specimens figured: figure 1, *P. Wilson 81*, Porto Rico; 2–7, *L. M. Underwood*, Jamaica, 1903; 8–12, *R. S. Williams 889*, Panama; 13–15, from a plant grown at the N. Y. Botanical Garden, probably self-sown from Jamaica spores.

PLATE 17. VITTARIA LATIFOLIA Benedict

FIG. 1. Whole plant, showing general habit, venation, and soriation.

FIG. 2. Cross-section of leaf through fertile part, showing very slight depression in which sporangia are borne.

FIG. 3. Cross-section of leaf below fertile part.

FIG. 4. Cross-section of petiole about 2 mm. above stem.

FIGS. 5–8. Successive cross-sections of petiole less than 2 mm. from stem, showing single leaf-trace and its division.

FIG. 9. Cross-section of stem, showing origin of a petiole and a leaf-trace.

FIG. 10. Stem scale, showing cilia, most of which have been broken off.

All the figures were drawn from type material, *R. S. Williams 1337*, Bolivia.

PLATE 18. VITTARIA STIPITATA Kunze

FIG. 1. Whole plant, showing general habit and soriation.

FIG. 2. Cross-section of leaf in fertile part.

FIG. 3. Cross-section of leaf below fertile part.

FIGS. 4 and 5. Cross-sections of petiole more than 2 mm. above stem.

FIG. 6. Cross-section of stem showing origin of a petiole with a leaf-trace not yet divided.

FIG. 7. Whole plant, about the smallest seen.

FIG. 8. Cross-section of leaf of larger plant of same collection number.

FIG. 9. Single leaf attached to stem; the leaf was about the longest and broadest observed.

FIG. 10. Cross-section through fertile part of same leaf shown in fig. 9.

FIG. 11. Cross-section through fertile part of another somewhat different leaf.

FIGS. 12–14. Cross-sections of same leaf about where the blade narrows into the petiole. The shaded strip below represents the band of collenchyma which runs part way up the blade.

FIGS. 15 and 16. Scales with an unusual amount of cell development.

FIGS. 17–19. Scales of the usual type.

FIG. 20. An old scale from which the softer parts of the cells have been lost.

Specimens figured: figures 1–6, *W. R. Maxon 4476*, Cuba; 7 and 8, *R. S. Williams 1338*, Bolivia; 9 and 10, *H. H. Smith 2568*, Colombia; 11–14, 17–19, *R. S. Williams 890*. Panama; 15 and 16, *Wercklé*, Costa Rica; 20, *H. H. Smith 1112*, Colombia.

PLATE 19. VITTARIA RUIZIANA Fée

FIG. 1. Whole plant, showing general habit, venation, and soriation. The petioles are unusually short in this plant.

FIGS. 2 and 3. Cross-sections through fertile part of a leaf, showing pointed margin, and the sporangial groove, which is much shallower than in *V. stipitata* Kunze.

FIG. 4. Cross-section through petiole more than 2 mm. above stem, showing heavy collenchymatous development with aerated central portion. The leaf-trace has divided into the midvein and two lateral veinlets.

FIG. 5. Cross-section through fertile part of leaf of type collection.

FIG. 6. Cross-section through fertile part of an unusually narrow leaf.

FIGS. 7 and 8. Cross-sections through petiole more than 2 mm. above stem.

FIG. 9. Cross-section through petiole very close to stem, and before simple leaf-trace has divided.

FIG. 10. Stem scale.

FIG. 11. Petiole scale.

Specimens figured: figures 1–4, *H. H. Smith 1112* (in National Herbarium), Colombia; 5, 11, *Moritz 143*, Tovar, Venezuela (type 6–10, *Sodiro*, Ecuador).

PLATE 20. VITTARIA WILLIAMSII Benedict

FIG. 1. Single leaf, showing soriation and the extreme of length noted.

FIG. 2. Whole plant (*type*), showing general habit, venation, and soriation.

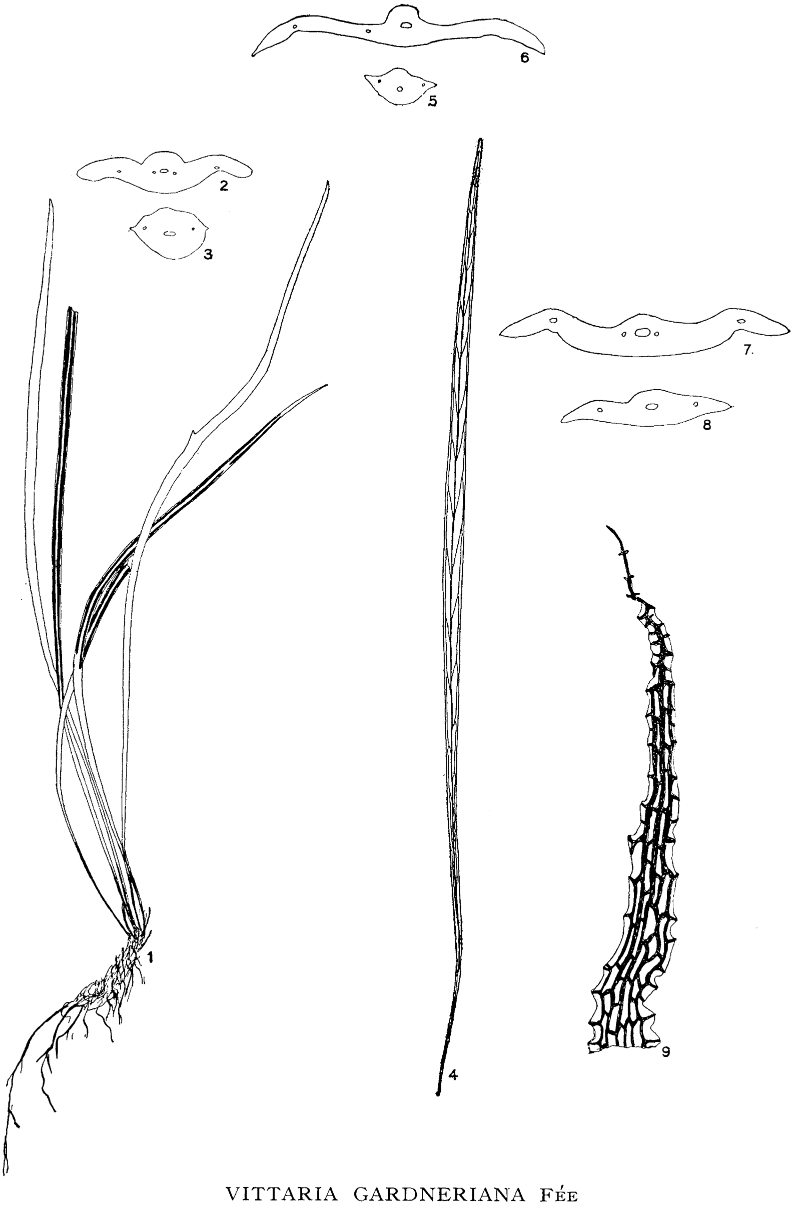
FIG. 3. Cross-section of half of leaf in fertile part, showing very slight depression where sporangia are borne.

FIG. 4. Cross-section through leaf below fertile part.

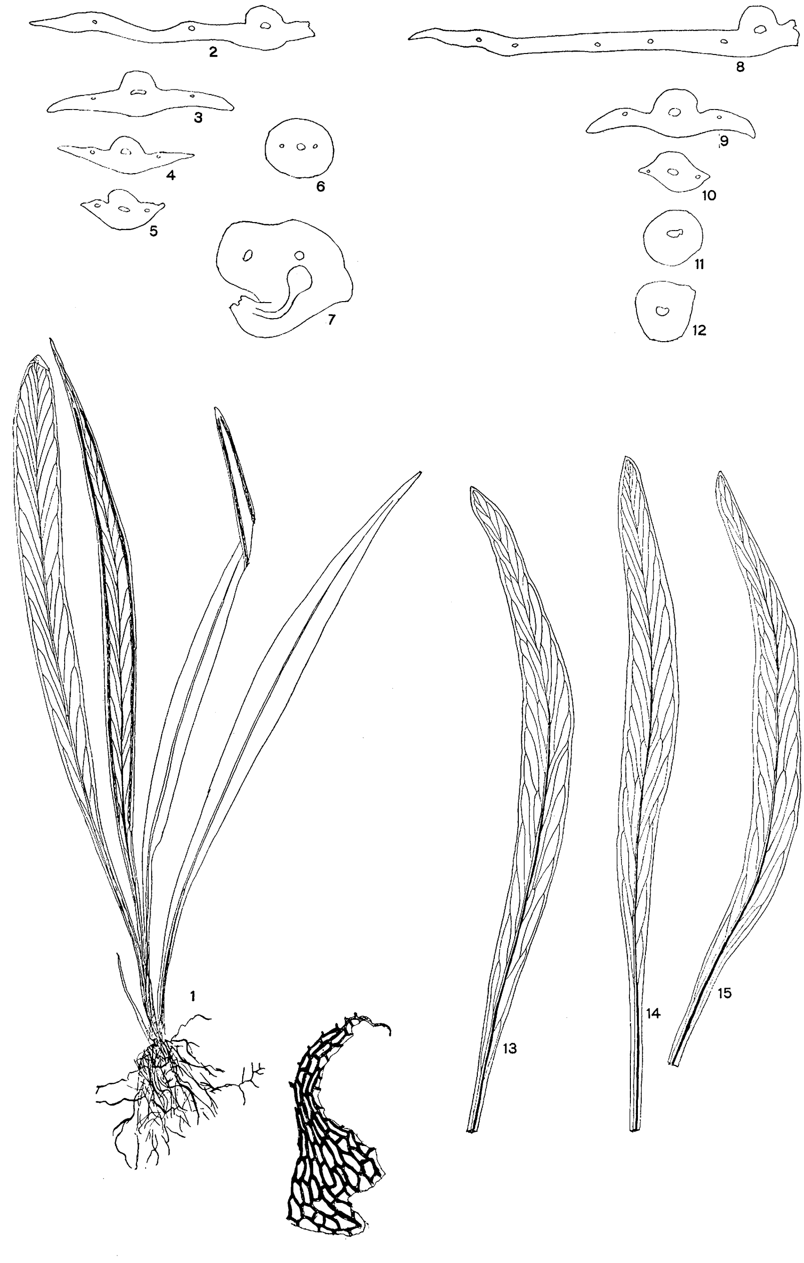
FIG. 5. Cross-section through petiole more than 2 mm. above stem.

FIG. 6. Scale showing the very heavily thickened apical portion.

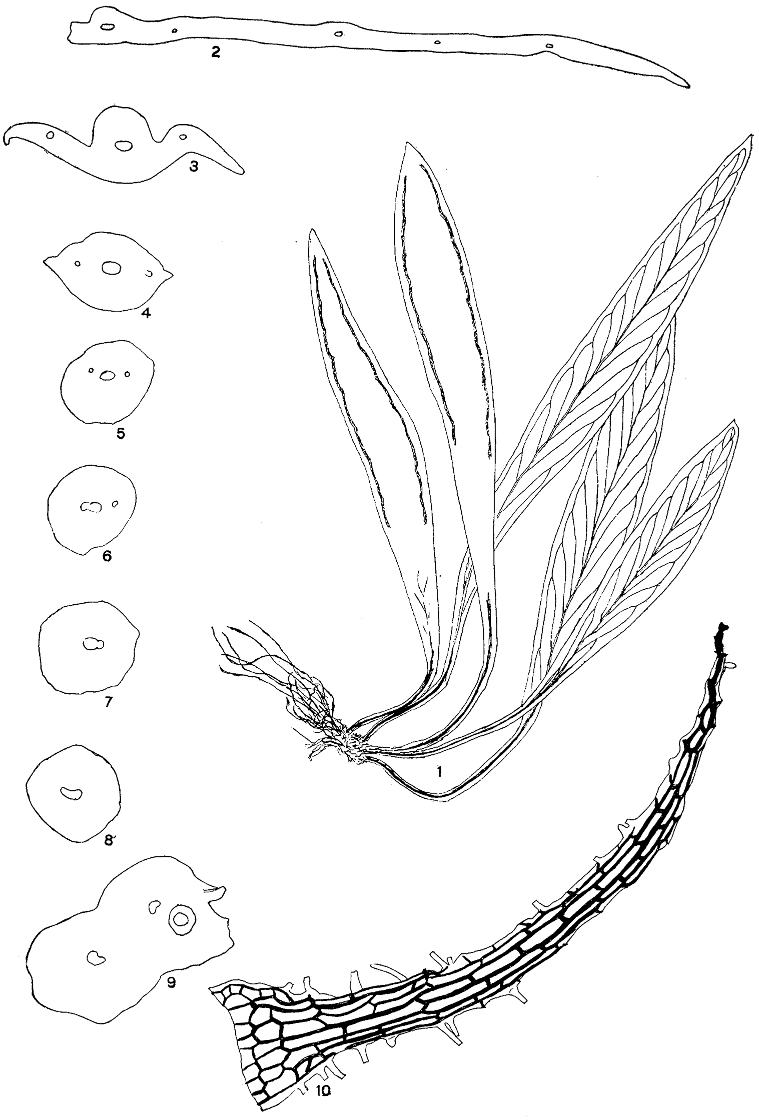
Specimens figured: figure 1, *Rusby 339*, Yungas, Bolivia; 2–6, all from type material.



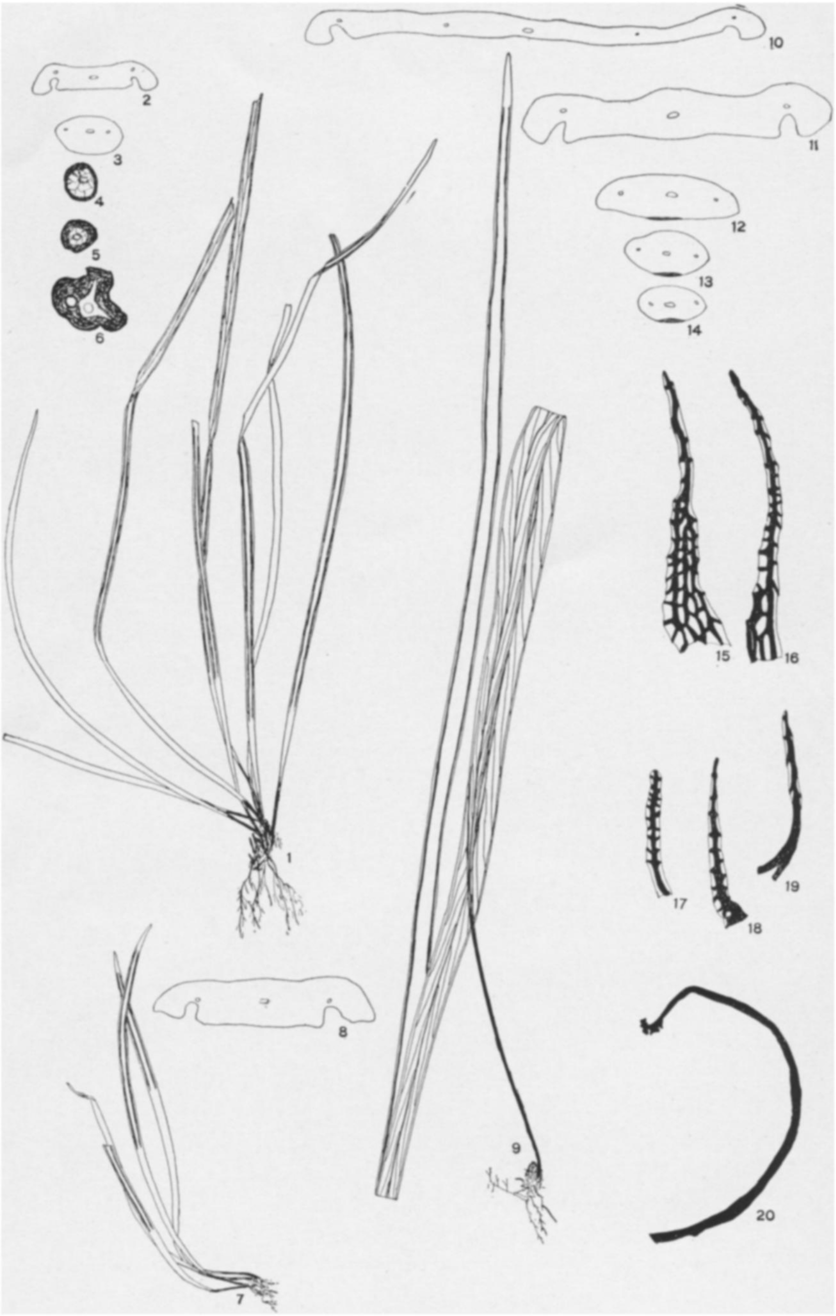
VITTARIA GARDNERIANA Fée



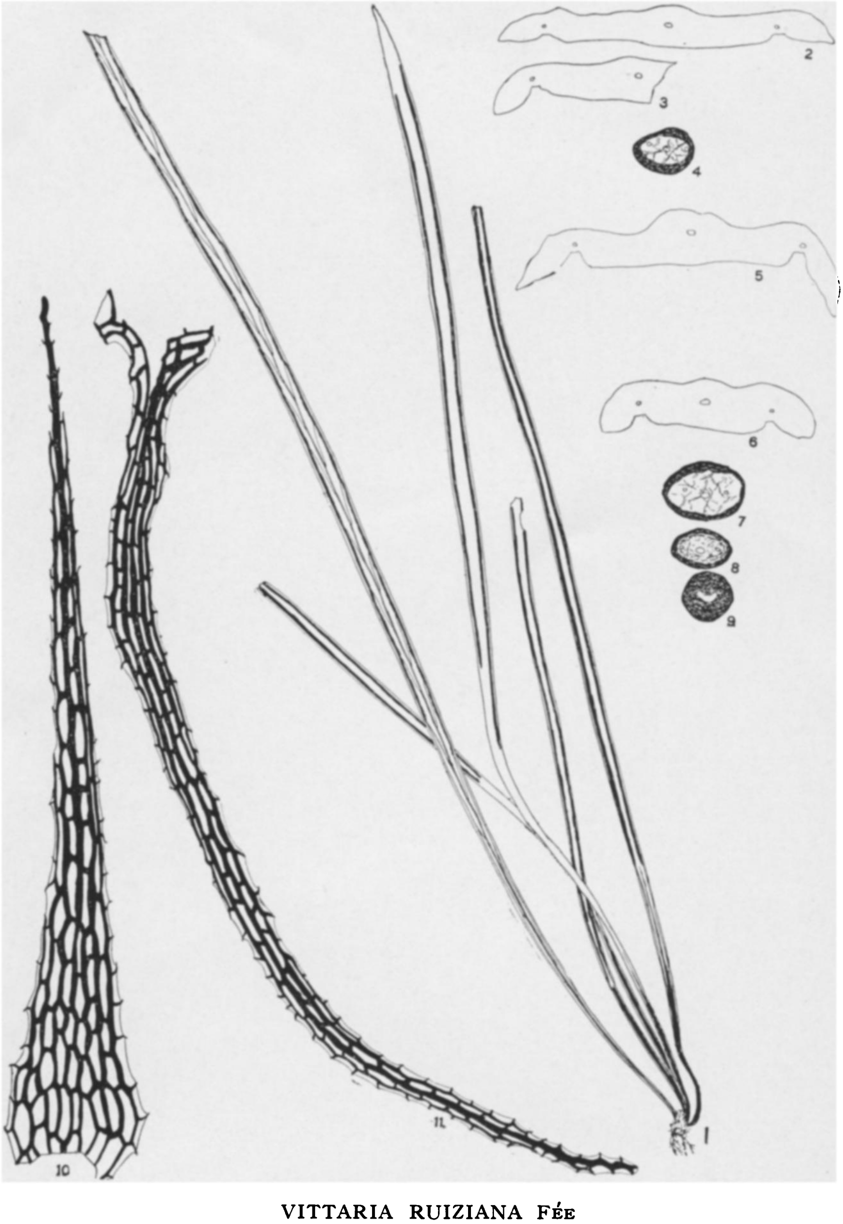
VITTARIA REMOTA Fée



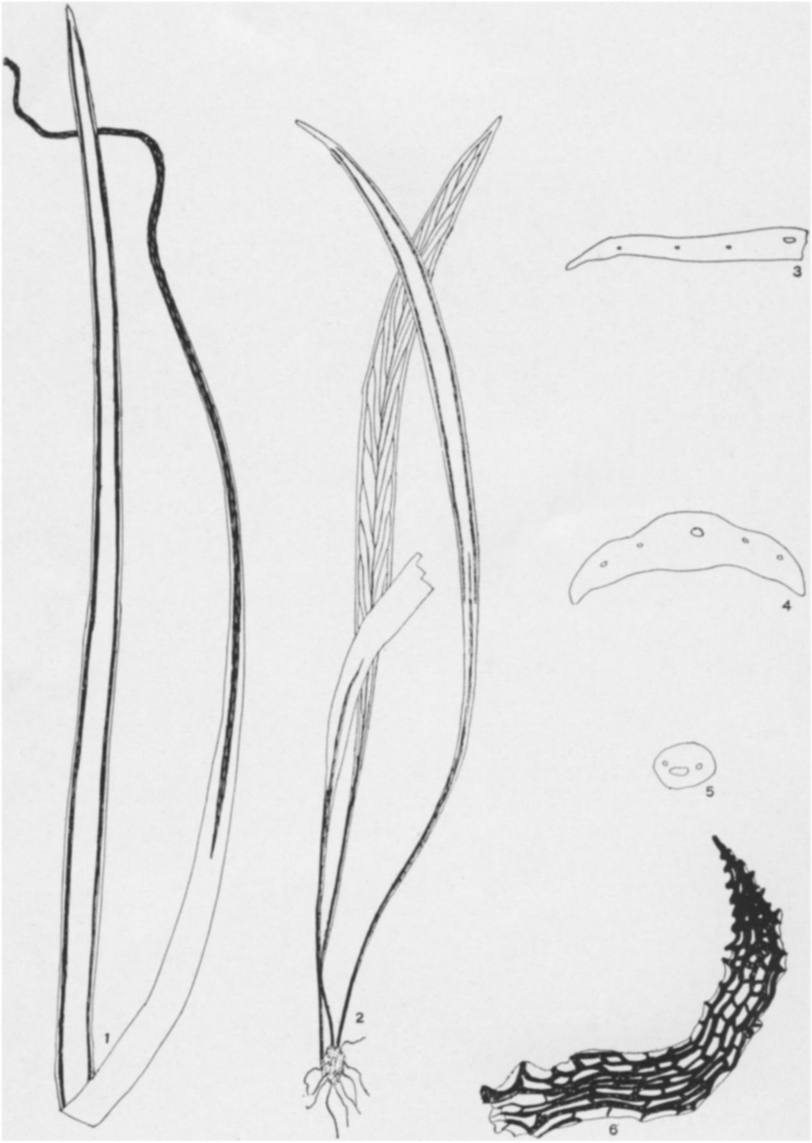
VITTARIA LATIFOLIA Benedict



VITTARIA STIPITATA KUNZE



VITTARIA RUIZIANA FÉE



VITTARIA WILLIAMSII BENEDICT